

FORCE TRANSMISSION USING SYNTHETIC FLUIDS**Publication number:** GB1357406**Publication date:** 1974-06-19**Inventor:****Applicant:** MONSANTO CO**Classification:****- international:** *F15B21/00*; C10M; *F15B21/00*; (IPC1-7): C10M3/10**- European:** C10M3/00**Application number:** GB19710044100 19710922**Priority number(s):** US19700074900 19700923; US19700084222 19701026**Also published as:**

FR2107900 (A1)

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[Return to Esp@Cenet home page](#)**Abstract of GB1357406**

1357406 Hydraulic fluids MONSANTO CO 22 Sept 1971 [24 Sept 1970 26 Oct 1970] 44100/71 Heading C5F Hydraulic fluids comprise hydrogenated linear alpha-alkylstyrene dimers of formula where R is C 1 - C 4 alkyl and n is 0, 1 or 2, optionally with up to 20 wt. per cent of cyclic dimers of formula The composition may also contain up to 50 wt. per cent of other synthetic base stocks (examples of cyclic hydrocarbons are given) and minor amounts of conventional additives, e.g. polymethacrylates, polyalkylstyrenes, vinyl acetate/ alkyl fumarate copolymers, methacrylate/vinyl pyrrolidone copolymers, 2,6-di-t-butyl-p-cresol, phenyl-alpha-naphthylamine, and dilauryl selenide. Reference has been directed by the Comptroller to Specification 1,257,473.

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PATENT SPECIFICATION

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(54) FORCE TRANSMISSION USING SYNTHETIC FLUIDS

(71) We, MONSANTO COMPANY, a corporation organised under the laws of the State of Delaware, United States of America, of 800 North Lindbergh Boulevard, St. Louis 66, Missouri, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to improvements in the transmission of force in mechanical devices. More specifically, it relates to a method of using certain synthetic hydrocarbon fluids in apparatus in which mechanical forces are transmitted or absorbed by or through the fluid, e.g., in automotive transmissions, tractive drives, hydraulic systems, shock absorbers, hydraulic steering mechanisms, clutches and other hydraulically operated devices.

Along with the development of various mechanisms for transmitting power has arisen the need for suitable fluids which perform essential functions in the operation of those mechanisms. Operation of these complex mechanisms often requires that the fluid function in several different capacities. The fluid not only serves as a lubricant and coolant in reducing the friction and heat developed during operation of the mechanism, but also performs other key functions. In the case of conventional automatic transmissions for automotive vehicles, for example, the fluid functions hydrokinetically in the fluid coupling or torque converter, depending upon the type of transmission, and in the hydraulic operation of the various mechanical components of the driving unit.

In the case of tractive drives, the torque is transmitted from an input element to an output element through nominal point or line contact typically with a rolling action by virtue of the traction between the contacting elements. While tractive elements are commonly spoken of as being in contact, it is

generally accepted that a fluid film is provided there between. Almost all tractive drives require fluids to remove heat, to prevent wear at the contact surfaces, and to lubricate bearings and other moving parts associated with the drive. Thus, instead of metal to metal rolling contact there is a film of fluid introduced into the load zone. The nature of this fluid determines to a large extent the limits of performance and the capability of the drive.

In the case of most hydraulic systems, the hydraulic fluid must lubricate the frictional parts of the system in addition to performing the primary function of transmitting power. The parts which are so lubricated include the frictional surfaces of the fluid pump, operating pistons, cylinders, valves and fluid motors. Many of these components are complex mechanical devices.

Conventional automatic transmissions, industrial hydraulic systems, gear reducers, tractive drives, and the like, generally employ functional fluids having base stocks selected from naturally occurring oils of mineral origin. It is well known, however, that such mineral oils, even upon subsequent refining, do not possess the characteristics which enable them to perform satisfactorily in such demanding applications. Thus, it is a general practice to add small amounts of other materials to these base stocks to affect one or more of the properties thereof. Because of increasing performance requirements imposed on many functional fluids, however, it has become difficult to find additives which will still perform the functions for which they are added and yet not introduce other problems such as increasing corrosion and causing harmful deposits.

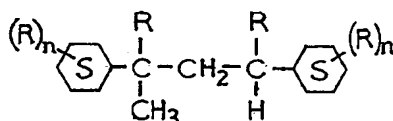
The useful life of any functional fluid can generally be adjudged on the basis of criteria such as the extent of viscosity increase, the extent of corrosion to metal surfaces in contact with the fluid, and the extent of deposits. Modern fluids for automatic transmissions including tractive drives employ highly refined

mineral oil base stocks with multipurpose additive packages incorporated therein. Even the most modern formulated mineral oils, however, are often marginal in long term performance when subjected to the thermal and oxidative stresses found in to-day's automatic transmissions for motor vehicles.

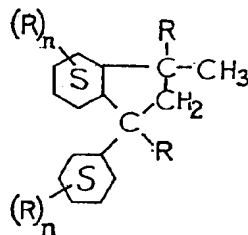
Synthetic hydrocarbon base stocks offer the potential for creating fluids which are vastly superior to mineral oil base stocks in oxidative stability and long term performance. Many synthetic fluids however, are found to cause corrosion when brought into contact with common materials, and others have been disqualified because of unsuitable viscosity properties.

The synthetic fluids used in accordance with the present invention have outstanding oxidation resistance, desirable viscosity properties, and high coefficient of traction.

One aspect of the present invention is a method of transmitting force by the hydrokinetic action of a fluid, in which the fluid has a base stock consisting of (i) a hydrogenated linear alpha-alkylstyrene dimer represented by the formula



where each R is an alkyl group of 1 to 4 carbon atoms and can be the same or different, and each n has the value 0, 1 or 2, or a mixture of two or more such hydrogenated linear dimers; (ii) a mixture of (i) with up to 20% by weight of the mixture of one or more hydrogenated cyclic dimers of the formula



where R and n are as defined in (i); or (iii) a combination of (i) or (ii) with one or more other synthetic fluids, said combination containing at least 50% by weight of (i) or (ii).

A further aspect of the invention is a method of transmitting force through a fluid dispersed on relatively rotatable tractive surfaces in torque-transmitting relationship, in which the fluid has a base stock consisting of (i) a hydrogenated linear alpha-alkylstyrene

dimer represented by formula (I) above or a mixture of two or more such hydrogenated linear dimers; or (ii) a mixture of (i) with up to 20% by weight of the mixture of one or more hydrogenated cyclic dimers of formula II.

Base stocks for power transmission equipment comprising the above synthetic fluids are characterised by having exceptional oxidative stability, excellent viscosity properties over a wide temperature range, and high tractive coefficients. The fluids are compatible with conventional viscosity index improvers, and the viscosity of the fluid can accordingly be controlled to suit the requirements of the particular application. The fluids are particularly well suited for use in automatic transmissions of both the conventional and tractive type and as hydraulic fluids in, for example, power steering mechanisms.

Accordingly the invention further includes a device in which force is transmitted by the hydrokinetic action of a fluid, in which the said fluid is a fluid as defined above with reference to the method of transmitting force by the hydrokinetic action of a fluid; and also includes a tractive drive mechanism in which the tractant fluid is a fluid as defined above with reference to the method of transmitting force through a fluid dispersed on relatively rotatable tractive surfaces.

The synthetic fluids of this invention comprise hydrogenated dimers of alpha-alkyl styrenes and ring substituted alkyl-alpha-alkyl styrenes. The hydrogenated linear dimers are found to have somewhat better viscosity properties and greater oxidative stability than the hydrogenated cyclic dimers, and are accordingly the preferred compositions. Minor proportions of cyclic dimers which naturally form during the dimerisation reaction can be tolerated without serious adverse effect on viscosity or oxidative stability, provided that the synthetic fluids contain not more than 20% of the cyclic dimers. A preferred base stock consists of from 90 to 100% by weight of the hydrogenated linear dimer and from 10 to 0% by weight of the hydrogenated cyclic dimer.

Although the alkyl group of the alpha-alkyl styrene can contain from 1 to 4 carbon atoms, it is generally preferred that this alkyl group be methyl or ethyl. The preferred synthetic fluids for use in this invention are accordingly hydrogenated linear dimers of alpha-methylstyrene and alpha-ethylstyrene, hydrogenated linear co-dimers of alpha-methylstyrene and alpha-ethylstyrene, and mixtures thereof.

A particularly preferred fluid for purposes of the present invention is the hydrogenated linear dimer of alpha-methylstyrene, 2,4-dicyclohexyl-2-methylpentane. The corresponding cyclic dimer is the compound of Formula II in which R is methyl and n is 0. Data are presented hereinafter to illustrate the superior oxidative stability of 2,4 - dicyclohexyl - 2-

methylopentane when compared to one of the best mineral oil base fluid formulations currently employed in automatic transmissions. Other data illustrate the exceptionally good tractive properties of this fluid which make it particularly desirable for use in tractive drives.

By way of example, other hydrogenated linear dimer fluids defined by Structure I and included within the scope of the present invention are 2,4 - dicyclohexyl - 2 - methylhexane, 3,5 - dicyclohexyl - 3 - methylhexane, 3,5 - dicyclohexyl - 3 - methylheptane, and 2,4 - di(4 - methylcyclohexyl) - 2 - methylpentane. Also within the scope of the present invention are the cyclic dimers defined by Structure II which corresponds to the linear dimers enumerated above and are usually formed as coproducts of the dimerization reaction.

Automatic transmission fluids including tractive fluids are usually based on hydrocarbon oils which are generally paraffinic in nature. The additive package incorporated in the base stock is designed to accomplish numerous effects. Many of the additives within the package are multifunctional, and it is therefore not always necessary to use a separate additive for each purpose. The usual types of additives found in automatic transmission fluids are oxidation inhibitors, dispersants, metal deactivators, viscosity index improvers, antiwear agents, rust inhibitors, corrosion inhibitors, foam inhibitors, seal swellers and friction modifiers.

Physical conditions in the modern automatic transmission are conducive to oxidation of the working fluid. The rapid flow of fluid through the unit which brings fluid and air into intimate contact, high fluid temperatures and the catalytic effect of the various metals all combine to accelerate oxidation. The result of uncontrolled oxidation is the formation of varnish, sludge and organic acids, the latter being potentially corrosive to metal components. In addition, the fluid may thicken excessively and adversely affect performance.

A well known qualification standard for conventional automatic transmission fluids is identified as "General Motors Standards for

Automatic Transmission Fluid, Type A Suffix A". Because newer transmissions and higher output engines have placed greater demands on the transmission fluid, the General Motors Corporation developed a new fluid specification called "Dexron" (Registered Trade Mark) which is the successor to the Type A Suffix A specification.

The Dexron type fluid, employed herein as a reference for comparison with 2,4 - dicyclohexyl - 2 - methylpentane, was a mineral base hydrocarbon containing an additive package conforming to the Dexron specification. The 2,4 - dicyclohexyl - 2 - methylpentane contained about 3% by weight of the corresponding cyclic dimer and 1% by weight of 2,6-di - t - butyl - p - cresol, an oxidation inhibitor. Oxidation inhibitors are conventionally added to synthetic base stock fluids to further enhance their stability. Examples of suitable inhibitors include hindered phenols such as utilized herein, aromatic secondary amines such as phenyl - alpha - naphthylamine, and organometallic compounds such as dilauryl selenide.

To illustrate the superior oxidative stability of 2,4 - dicyclohexyl - 2 - methylpentane over the reference Dexron fluid, an oxidation and corrosion test was conducted according to the basic procedure set forth in Federal Test Method Standard 791-5308, under the specific test conditions defined below. In general, this test measures increase in fluid viscosity and acidity, change in physical appearance of the fluid and metal corrosion, after exposure for a given period at a constant temperature to a flow of dry air.

The following Tables I, II, III and IV present comparative oxidation and corrosion performance of the reference Dexron fluid and a preferred synthetic fluid of the present invention, viz., 2,4 - dicyclohexyl - 2 - methylpentane. Test conditions for the data of Tables I through IV were as follows:

Sample Size	120 cc.
Air Flow	5 liters/hr. of dry air
Temperature	350° F.
Exposure Time	72 hours
Metals Present	Al, Cu, Fe, Mg.

TABLE I

Acidity

Fluid	Initial T.A.N.	Final T.A.N.
Dexron Fluid	1.70	6.1
2,4-dicyclohexyl-2-methylpentane	0.01	0.17

TABLE II

100°F. Viscosity Increase

Fluid	Initial Viscosity—Cs	Final Viscosity—Cs	% Viscosity Increase
Dexron Fluid	39.08	72.22	87
2,4-dicyclohexyl-2-methylpentane	22.70	23.27	2.5

TABLE III

Coke and Sludge Formation

Fluid	Coke	Sludge
Dexron Fluid	None	Medium
2,4-dicyclohexyl-2-methylpentane	None	None

TABLE IV

Weight Change of Metal Specimens

Fluid	Aluminum mg/cm ²	Iron mg/cm ²	Copper mg/cm ²	Magnesium mg/cm ²
Dexron Fluid	+0.02	+0.01	-0.49	0.00
2,4-dicyclohexyl-2-methylpentane	0.00	+0.01	-0.01	0.00

From the data reported in Tables I through IV above, it will be seen that the synthetic fluid of the present invention, viz., 2,4 - dicyclohexyl - 2 - methylpentane, gave results superior to those of the reference Dexron fluid. With particular reference to Table IV, it will be observed that the Dexron fluid exhibited a significant degree of copper corrosion as evidenced by a weight loss of 0.49 mg/cm² in the copper test specimen. The synthetic hydrocarbon 2,4 - dicyclohexyl - 2 - methylpentane, on the other hand, produced practically no weight loss in the copper specimen with which it was in contact. These corrosion results are corroborated by the comparatively high total acid number ascribed to the Dexron fluid in the data of Table I.

Fluid viscosity is an important parameter in most power transmission systems, and especially in those systems wherein the fluid must perform under wide temperature variations. An automatic transmission fluid is required to meet certain initial viscosity standards, and it is desirable that any change in viscosity properties during use should be minimal. With reference to the results in Table

II, it is observed that the Dexron fluid viscosity at 100° F. increased 87% during the 72 hours oxidation and corrosion test. This is contrasted with a viscosity increase of only 2.5% for 2,4 - dicyclohexyl - 2 - methylpentane after 72 hours of exposure.

The Dexron fluid specification requires a minimum viscosity at 210° F. of 49.0 SUS, which is equivalent to 7.0 cs. It specifies a maximum Brookfield viscosity of 4000 cs. at -10° F. and 55,000 cs. at -40° F. The temperature viscosity data for 2,4 - dicyclohexyl - 2 - methylpentane containing 3% cyclic dimer are as follows:

TABLE V.

Temperature, °F.	Viscosity, cs.
-20	31,600
0	3,500
100	23
210	3.7

The addition of small amounts of a viscosity attenuator would be effective to reduce low temperature viscosity and conform 2,4-di - cyclohexyl - 2 - methylpentane to the

Dexron specification. Suitable attenuators include low viscosity compositions which are compatible with 2,4 - dicyclohexyl - 2 - methylpentane, e.g., bicyclohexyl, isopropylbicyclohexyl, and perhydrophenanthrene.

- 5 The addition of a minimal amount of a viscosity index improver would be effective to increase the high temperature viscosity to conform to the Dexron specification. Suitable
- 10 V.I. improvers include the polyalkyl methacrylates in which the alkyl groups have from about 2 to 16 carbon atoms and may be, for example, ethyl, propyl, butyl, amyl, hexyl, etc., and mixtures thereof. The alkyl groups
- 15 may be mixtures such as derived from a mixture of alcohols, and in which case there may be included some alkyl groups having as low as 1 carbon atom and as high as about 18 carbons atoms. The alkyl group is preferably
- 20 a normal alkyl group, but may be a branched chain or cycloalkyl group.

One example of a suitable V.I. improver for use with 2,4 - dicyclohexyl - 2 - methylpentane and other fluids of this invention is

a copolymer of butyl and lauryl methacrylate with a molecular weight of about 40,000. Another example is a terpolymer of butyl methacrylate, lauryl methacrylate, and vinyl pyrrolidone wherein the molecular weight is about 40,000. Still another V.I. improver is polyisobutylene prepared by acid-catalyzed polymerization of isobutylene up to a molecular weight between 20,000 and 40,000. Another

30 is polyalkyl styrene prepared by polymerization of alkyl styrene, where the alkyl group is preferably lauryl, and the molecular weight is 45,000 to 50,000. Yet another V.I. improver useful in the present invention is a copolymer of vinyl acetate and alkyl fumarate having a molecular weight between 40,000 and 60,000. Alkyl acrylates such as ethyl acrylate and octyl acrylate may also be employed.

The effect of three conventional acrylate-type V.I. improvers on the viscosity of 2,4-dicyclohexyl - 2 - methylpentane was determined over a temperature range of -20° F. to 200° F. The measured viscosities in centistokes are given in the table below:

TABLE VI

Fluid	V.I. Improver	Temperature, °F.			
		-20	0	100	200
1	None	31,600	3,500	22	3.7
2	1.5% "A"	33,300	3,400	26	4.5
3	1.5% "B"	37,500	3,900	27	4.6
4	3.0% "C"	42,000	5,600	33	5.5

"A" — alkylmethacrylate — vinyl pyrrolidone copolymer

"B" — long-alkylmethacrylate polymer

"C" — alkylmethacrylate polymer — low M.W.

- 50 The viscosity characteristics of 2,4 - dicyclohexyl - 2 - methylpentane are unique and particularly desirable for a tractive fluid. Most of the tractive fluids heretofore available are either solids or extremely viscous
- 55 fluids at -20° F., and others which have an operable viscosity at -20° F. typically have an undesirably low viscosity at the higher temperatures. For most tractive applications, it is

preferable that the fluid have a viscosity of less than about 50,000 centistokes at -20° F. and more than about 3.5 centistokes at about 200° F. Hydrogenated linear dimer of α -methylstyrene containing 3% cyclic dimer meets these viscosity requirements as illustrated by the data in Table V above. Comparable viscosity data for several other tractants representative of the prior art are as follows:

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TABLE VII

Reactant	Viscosity	
	-20°F.	210°F.
Bicyclohexyl	Solid	1.2
α -Cyclopentylbicyclohexyl	Solid	3.0
1,2-Tercyclohexyl	>200,000	4.3
1,3-Tercyclohexyl	Solid	4.9
Dicyclohexylmethane	Solid	1.4
1,1-Dicyclohexylethane	<1000	1.7
Cyclohexyl (α -ethylcyclohexyl)methane	<1000	1.7
1,1,3-Tricyclohexylpropane	<200,000	9.0
Hydrogenated dicumyl	Solid	4.8

5 The low temperature viscosity of mixtures of linear and cyclic dimers of α -methylstyrene were also measured to determine the effect of increasing concentrations of the cyclic component. The viscosity data illustrate that for

applications which require low temperature operability, the maximum permissible concentration of cyclic dimer is limited to about 20%.

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TABLE VIII

% by weight cyclic dimer in mixture	3	7	13	22	100
-20°F. Visc. cs.	31,600	32,400	36,700	52,400	>200,000

15 There are certain applications such as in automatic transmissions wherein additives other than viscosity index improvers and oxidation inhibitors are beneficial to the performance of the instant alkylene-linked cyclohexyl compounds. It may be desirable, for example, to add minor amounts of seal swellers, defoaming additives, antiwear additives, dispersants, dyes and other useful substances. It is to be understood, therefore, that those skilled in the art will visualize certain conventional additives which can be incorporated in the synthetic fluids taught by the present invention for the purpose of enhancing one or more fluid properties.

The oxidative stability of 2,4 - dicyclohexyl - 2 - methylpentane as representative of the class of compounds taught by the present invention compares favorably with that of tetraalkyl substituted alkylene linked dicyclohexyl compounds such as 2,3 - dicyclohexyl - 2,3 - dimethylbutane which are recognized for their exceptional oxidative stability. In an oxidation and corrosion test conducted according to the method previously described, the 100° F. viscosity increase and final acid number for these two fluids, each containing 1% 2,6 - di - t - butyl - p - cresol, were as follows:

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TABLE IX

	% Viscosity Increase	Final T.A.N.
2,4-dicyclohexyl-2-methylpentane	2.5	0.17
2,3-dicyclohexyl-2,3-dimethylbutane	2.4	0.10

The excellent stability of 2,4 - dicyclohexyl - 2 - methylpentane and the favorable comparison with 2,3 - dicyclohexyl - 2,3-dimethylbutane is most surprising on consideration of the chemical structure of this compound. The relationship of oxidation stability to compound type and structure is well recognized, and has been summarized for example by W. S. Dukek, J. Inst. Pet. 50, 276 (1964) as follows:

"Among hydrocarbons, alkyl aromatics are most easily oxidized, followed by diolefins, mono-olefins, and paraffins. Structure as well as type influence ease of oxidation. Tertiary hydrogen is most easily removed, followed by secondary and primary hydrogens. The resulting peroxides are stable in the same order."

In the case of the present compounds, 2,3-dicyclohexyl - 2,3 - dimethylbutane, has two tertiary hydrogen atoms attached to ring carbon atoms. The hydrogens however, are shielded by the cyclohexyl groups and by the methyl groups on adjacent carbon atoms, and are accordingly protected from oxidation. The 2,4 - dicyclohexyl - 2 - methylpentane, on the other hand, has three tertiary hydrogen atoms, one of which is attached to a bridging carbon atom. This additional tertiary hydrogen atom not only increases the potential for oxidation, but also reduces the degree of shielding afforded the tertiary hydrogen on the adjacent ring carbon atom. As a consequence, both these hydrogen atoms would be expected to be quite susceptible to oxidation, and it is quite surprising that, contrary to theory, 2,4 - dicyclohexyl - 2 - methylpentane appears essentially equivalent to 2,3 - dicyclohexyl - 2,3 - dimethylbutane in the above oxidation test.

EXAMPLE.

The coefficient of traction of the hydrogenated linear dimer of α -methylstyrene, of the unhydrogenated linear dimer, and of hydrogenated cyclic dimer were determined on a rolling disk machine. This machine was designed to predict the performance of a fluid in variable speed drives and comprises two hardened steel rollers which may be loaded one against the other and driven at any required speed. The fluid is introduced between the rollers and the relationships between applied load, roller surface speeds, relative sliding speed between the two rollers, and torque transmitted from one roller to the other through the contact between them are a measure of the potential performance of the fluid in a variable speed drive. Literature references on this rolling disk machine include M. A. Flint [Proceedings of the Inst. of Mech. Engrs., vol. 180, pp 225, 313 (1965-66)]; "The Lubrication of Rollers, I" by

A. W. Crook [Phil. Trans. A 255, 281 (1963a)].

The cyclic dimer was prepared by dimerizing α -methylstyrene at 150° C. and distilling the dimerized product to yield cyclic dimer containing about 1 percent linear dimer as a minor constituent. The following data were obtained at a fluid temperature of 200° F., a disk speed of 3,000 RPM with 1% slip, and a Hertz stress of 400,000 psi.

TABLE X.

Material	Avg. Coef. of Traction	
Hydrogenated Linear Dimer	0.094	75
Hydrogenated Cyclic Dimer	0.090	
Unhydrogenated Linear Dimer	0.066	

These data illustrate that hydrogenation increases the coefficient of traction of the linear dimer by a considerable degree, and that the coefficient of traction of hydrogenated linear dimer is higher than that of hydrogenated cyclic dimer.

The following describes a method of preparing 2,4 - dicyclohexyl - 2 - methylpentane, a preferred compound for use in the present invention.

A one liter autoclave was charged with 51 grams of Raney nickel catalyst and 600 grams of α -methylstyrene dimer which was a mixture of about 97% 2,4 - diphenyl - 4 - methyl - 1 - pentene and 2,4 - diphenyl - 4 - methyl - 2 - pentene dimers and 3% cyclic dimer. The catalyst was Raney No. 28 which had been prepared for the hydrogenation reaction by displacing the water with ethanol.

The autoclave was flushed with hydrogen and pressured to 500 psig. The reaction was maintained at about 60° C. and 500 psig with agitation for an initial reaction period of about 2 hours, following which the autoclave was slowly heated to 180° C. and maintained at that temperature for about 3 hours. The hydrogenation was completed by increasing the temperature to 200° C. at 500 psig for about 1 hour. Total reaction time was 4 hours.

After cooling and venting, the reaction product was removed from the autoclave and filtered. NMR analysis of the filtrate showed substantially complete hydrogenation of the unsaturated dimer with less than 0.1% unsaturation remaining. Low boilers were removed by a vacuum distillation to a head temperature of 135° C./0.9 mm. The hydrogenated product was a colorless oil having a refractive index, n_D 1.4878.

Anal: Calcd. for $C_{14}H_{24}$: C, 86.3; H, 13.7.
Found: C, 86.0; H, 13.8.

The above serves to illustrate one method whereby the fluids of the present invention are obtained by substantially complete hydrogen-

ation of unsaturated linear dimers of alpha-alkyl styrene. In a like manner, 3,5 - dicyclohexyl - 3 - methylpentane is obtained from linear dimer of alpha-ethylstyrene, and 3,5-dicyclohexyl - 3 - methylhexane and 2,4 - dicyclohexyl - 3 - methylhexane are obtained from the linear codimer of alpha-methylstyrene and alpha-ethylstyrene, and the like.

By "substantially complete hydrogenation" of unsaturated linear dimers of alpha-alkyl styrene is meant that less than about 2%, and preferably less than 0.5% unsaturation remains after hydrogenation.

While the fluids of the present invention are useful per se as automatic transmission and hydraulic fluids, it may, for certain applications, be advantageous to employ for a base stock a blend or mixture of two or more of the synthetic compounds taught herein to obtain a desired balance of physical properties, and such mixtures are accordingly within the scope of this invention.

It may also be advantageous for certain uses to employ as the fluid base stock one or more of the compounds taught herein, in combination with one or more other synthetic fluids outside the scope of the present invention. Thus, the compounds of the present invention may be present as one component of a multicomponent complex fluid formulation. It is generally preferred that the fluids of the present invention comprise a major proportion, i.e., at least 50% by weight of the total fluid and more preferably at least about 65% by weight of the fluid composition. Other synthetic fluids which may be used in conjunction with the base stock fluids of the present invention may be for example tetraalkyl substituted alkylene linked dicyclohexyl compounds which are known to be suitable synthetic fluids for automatic transmissions.

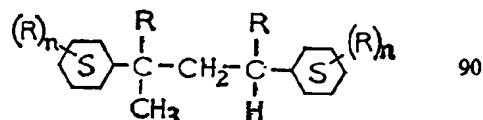
Although 2,4 - dicyclohexyl - 2 - methylpentane has been shown herein to have particular advantage as an automatic transmission fluid, the compound's utility is not so limited. The outstanding viscosity characteristics and oxidative stability of the compound make it a superior operating fluid in many other hydraulic systems and devices. A typical hydraulic system includes one or more displaceable members and a displacing force which is transmitted to said members by means of an operative fluid which is in communication therewith. While hydraulic systems will contain such elements as pumps, valves, cylinders, pistons and the like, the performance and endurance of the system necessarily depends upon the operative fluid. The viscosity characteristics of 2,4 - dicyclohexyl - 2-methylpentane make it advantageous for the transmission of power in a hydraulic system having a pump therein which supplies power for the system, e.g., in a fluid motor comprising a constant-discharge or variable-discharge piston pump which is caused to rotate by the pressure of the hydraulic fluid of

the system. The preferred fluid likewise serves to lubricate the frictional parts of such hydraulic systems. The outstanding oxidative stability of 2,4 - dicyclohexyl - 2 - methylpentane promotes cleanliness of a hydraulic system because of the resistance to sludge formation, deposits, corrosive attack and the like. The hydraulic systems envisioned in the present invention are understood to contain conventional fluid reservoir and fluid supply means.

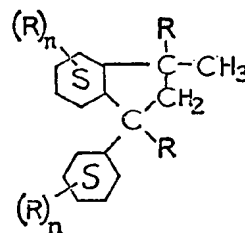
The fluids employed in the present invention, therefore, are useful as hydraulic fluids in many types of hydraulic machines, e.g., lifts, hoists, jacks, lockgates, presses, etc. They are likewise useful as the operative fluid in hydraulic steering mechanisms, wet clutches and other mechanical devices.

WHAT WE CLAIM IS:—

1. A method of transmitting force by the hydrokinetic action of a fluid, in which the fluid has a base stock consisting of (i) a hydrogenated linear alpha-alkylstyrene dimer represented by the formula



where each R is an alkyl group of 1 to 4 carbon atoms and can be the same or different, and each n has the value 0, 1 or 2, or a mixture of two or more such hydrogenated linear dimers; (ii) a mixture of (i) with up to 20% by weight of the mixture of one or more hydrogenated cyclic dimers of the formula



where R and n are as defined in (i); or (iii) a combination of (i) or (ii) with one or more synthetic fluids, said combination containing at least 50% by weight of (i) or (ii).

2. A method according to Claim 1, in which the base stock consists of from 90 to 100% by weight of the hydrogenated linear dimer and from 10 to 0% by weight of the hydrogenated cyclic dimer.

3. A method according to either of Claims 1 and 2, wherein each R in the formulae of the dimers is individually methyl or ethyl.

4. A method according to Claim 3, wherein the hydrogenated linear dimer is 2,4 - dicyclohexyl - 2 - methylpentane, and the cyclic

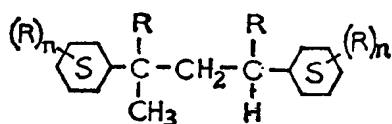
dimer is the compound in which R is methyl and n is 0.

- 5 5. A method according to any of Claims 1 to 4, wherein the fluid includes a viscosity index improver.

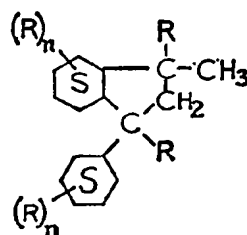
6. A device in which force is transmitted by the hydrokinetic action of a fluid, in which the operative fluid is a fluid in accordance with any of Claims 1 to 5.

- 10 7. A device according to Claim 6 that is an automatic transmission system.

8. A method of transmitting force through a fluid dispersed on relatively rotatable tractive surfaces in torque-transmitting relationship, in which the fluid has a base stock consisting of (i) a hydrogenated linear alpha-alkylstyrene dimer represented by the formula



- 20 where each R is an alkyl group of 1 to 4 carbon atoms and can be the same or different, and each n has the value 0, 1 or 2, or a mixture of two or more such hydrogenated linear dimers; or (ii) a mixture of (i) with up to 20% by weight of the mixture of one or more hydrogenated cyclic dimers of the formula



where R and n are as defined in (i).

9. A method according to Claim 8, in which the base stock consists of from 90 to 100% by weight of the hydrogenated linear dimer and from 10 to 0% by weight of the hydrogenated cyclic dimer.

10. A method according to either of Claims 8 and 9, wherein each R in the formulae of the dimers is individually methyl or ethyl.

11. A method according to Claim 10, wherein the hydrogenated linear dimer is 2,4-dicyclohexyl - 2 - methylpentane, and the cyclic dimer is the compound in which R is methyl and n is 0.

12. A tractive drive mechanism containing a tractant fluid in accordance with any of Claims 8 to 11.

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Reference has been directed in pursuance of Section 9, subsection (1) of the Patents Act 1949, to patent No. 1,257,473.